APPENDIX B

DEVELOPMENT OF RISK-BASED SCREENING LEVELS

Development of Risk-Based Screening Levels

Former Pechiney Cast Plate, Inc., Facility

3200 Fruitland Avenue, Vernon, California

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Former Pechiney Cast Plate, Inc., Facility
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This report was prepared by the staff of Geomatrix Consultants, Inc., under the supervision of the Senior Toxicologists whose signatures appear hereon.

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DEVELOPMENT OF RISK-BASED SCREENING LEVELS

Former Pechiney Cast Plate, Inc., Facility
3200 Fruitland Avenue
Vernon, California

1.0 INTRODUCTION

Risk-based screening criteria were used to evaluate potential human health risks associated with chemical exposure. California Human Health Screening Levels (CHHSLs) published by the California Environmental Protection Agency (Cal-EPA) Office of Environmental Health Hazard Assessment (OEHHA) (2005a) were used where available. These screening numbers were developed in cooperation with the Cal-EPA Department of Toxic Substances Control (DTSC) and the California State Water Resources Control Board as required by the California Land Environmental Restoration and Reuse Act. Risk-based screening levels (RBSLs) were developed for chemicals for which CHHSLs were not available or when more appropriate site-specific values were required (e.g., for the evaluation of potential risks to construction workers).

The site conceptual model describing the exposure assessment for this site is presented in the main text. The receptors identified included a commercial/industrial worker (indoor and outdoor) and a construction worker. This appendix presents the toxicity assessment, the development of RBSLs for each receptor for each medium of concern – soil and soil vapor – as appropriate, and an uncertainty analysis.

2.0 TOXICITY ASSESSMENT

The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the RBSLs are presented in Table B-1. The hierarchy of references used for selecting these toxicity criteria is as follows:

1. OEHHA Toxicity Criteria Database, 2008, or OEHHA Chronic Reference Exposure Levels, 2005b;

2. United States Environmental Protection Agency (U.S. EPA) Integrated Risk Information System (IRIS) on-line database, 2008; and

3. Other U.S. EPA toxicity criteria, as recommended or provided for specific chemicals in OEHHA, 2005a, Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil or U.S. EPA, 2004b, Region IX Preliminary Remediation Goals (PRGs), October. The other U.S. EPA sources include Provisional Peer-Reviewed Toxicity Values (PPRTVs), values from the

National Center for Environmental Assessment (NCEA), and values from U.S. EPA Health Effects Assessment Summary Tables, 1997.

In the event that an inhalation reference dose or slope factor was not available, route extrapolation from oral exposure was used in the calculations, unless clear toxicological evidence indicates this extrapolation is inappropriate for a specific chemical. Toxicity criteria for dermal exposure were derived using the oral reference dose (RfD) or cancer slope factor (CSF) without adjustment for reduced gastrointestinal absorption efficiency, consistent with the approach used to derive most CHHSLs (OEHHA 2005a). Surrogate toxicity criteria were used when no other criteria were available for a specific chemical. Specific surrogates were chosen based on similarities in chemical structure and expected toxicity. Surrogates used in this assessment are presented in Table B-1.

3.0 RISK-BASED SCREENING LEVELS FOR SOIL

Future exposure for the outdoor commercial/industrial worker and the construction worker was assumed to be complete for chemicals in soil via incidental ingestion, dermal contact, and inhalation of airborne particulates or volatile organic compounds[1] (VOCs) in ambient air. Future exposure for the indoor commercial/industrial worker was assumed to be complete for VOCs migrating from subsurface soil into indoor air. However, soil vapor is considered a more appropriate medium than soil for assessing potential vapor migration and soil vapor data were used to evaluate potential vapor migration to air and inhalation exposure.

CHHSLs for non-volatile chemicals in soil at a commercial/industrial site (OEHHA, 2005a) are protective of outdoor commercial/industrial worker exposure to soil via incidental ingestion, dermal contact, and inhalation of airborne particulates and have been developed for the nine non-volatile chemicals detected at the Site (after excluding the data not considered for the HHRA [see Section 4.2.1 of the main report]).[2] Additional RBSLs were developed for construction workers for these compounds following the same methodology but using construction worker exposure parameters because CHHSLs have not been developed by OEHHA for this receptor. For VOCs detected at the Site, soil vapor data were used to evaluate potential vapor migration to indoor and ambient air. RBSLs were developed for outdoor commercial/industrial workers and construction workers for the VOCs detected in soil

[1] Chemicals are identified as VOCs if the molecular weight is less than 200 grams per mole (g/mole) and the Henry's Law Constant is greater than 1×10^{-5} atmospheres–cubic meter per mole (atm-m^3/mole).

[2] For two of the nine chemicals, the calculated risk-based screening levels are the same as CHHSLs. For the remaining seven, Aroclor-1232, Aroclor-1248, Aroclor-1254, Aroclor-1260, cadmium, copper, and zinc, the rationale for the differences is provided in Table B-5.

to account for potential exposure via soil incidental ingestion and dermal contact. Lead was evaluated separately based on the unique health effects associated with this compound.

3.1 RISK-BASED SCREENING LEVELS FOR SOIL (NON-LEAD EXPOSURES)

The equations used to develop the RBSLs for soil for both outdoor commercial/industrial workers and construction workers are presented below. RBSLs were developed to screen for both cancer risks (Equation 1) and noncancer adverse health effects (Equation 2). These equations consider exposure via incidental ingestion, dermal exposure, and inhalation of particulates (using a particulate emission factor [PEF]). For VOCs, the inhalation pathway component (third component of denominator in Equations (1) and (2)) did not apply in the RBSL calculations.

$$RBSL_{soil-risk} = \frac{TR \times BW \times AT_{ca}}{ED \times EF \times \left[\left(\frac{IR_s \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{SAs \times SAF \times ABS \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{IHR_a \times ET \times CSF_i}{PEF}\right)\right]} \quad (1)$$

Where:

$RBSL_{soil-risk}$	=	risk-based soil screening level for cancer risk (mg/kg)
TR	=	target cancer risk, 1 x 10^{-6} (unitless)
BW	=	body weight (kg)
AT_{ca}	=	averaging time - cancer (days)
ED	=	exposure duration (yr)
EF	=	exposure frequency (days/yr)
IR_s	=	ingestion rate of soil (mg/day)
CSF_o	=	oral cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
CF_{kg-mg}	=	conversion factor from kilograms to milligrams
SAs	=	exposed skin surface area (cm^2)
SAF	=	soil-to-skin adherence factor (mg/cm^2)
ABS	=	dermal absorption factor (unitless)
IHR_a	=	inhalation rate (m^3/hr)
ET	=	exposure time (hr/day)
CSF_i	=	inhalation cancer slope factor [$(mg/kg\text{-}day)^{-1}$]
PEF	=	particulate emission factor (m^3 of air/kg of soil)

$$RBSL_{soil-haz} = \frac{THQ \times BW \times AT_{nc}}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IR_s}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_o} \times \frac{SAs \times SAF \times ABS}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_i} \times \frac{IHR_a \times ET}{PEF}\right)\right]} \quad (2)$$

Where:

$RBSL_{soil-haz}$	=	risk-based soil screening level for noncancer hazard (mg/kg)
THQ	=	target hazard quotient, 1 (unitless)
AT_{nc}	=	averaging time - noncancer (days)
RfD_o	=	oral reference dose (mg/kg-day)
RfD_i	=	inhalation reference dose (mg/kg-day)

All other terms previously defined

The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the RBSLs are presented in Table B-1. Chemical-specific dermal absorption factors used in deriving the RBSLs are presented in Table B-2. Values for exposure parameters used in the RBSL calculations are listed in Tables B-3 and B-4 for outdoor commercial/industrial workers and construction workers, respectively. Exposure assumptions for the commercial/industrial workers were obtained from OEHHA (2005a) and U.S. EPA (1991, 1996). Exposure assumptions for the construction worker were obtained from DTSC (1996, 1999a), and U.S. EPA (1991, 2002).

The RBSLs developed to screen the chemical concentrations in soil at the Site and estimate potential outdoor commercial/industrial worker cancer risks and noncancer hazards from exposure to these concentrations are presented in Table B-5. The RBSLs developed to screen the chemical concentrations in soil at the Site and estimate potential construction worker cancer risks and noncancer hazards from exposure to these concentrations are presented in Table B-6.

3.2 RISK-BASED SCREENING LEVELS FOR EXPOSURE TO LEAD IN SOIL

Although a CSF has been published by OEHHA for lead (OEHHA, 2008), noncarcinogenic health effects, particularly for children, occur at much lower concentrations than carcinogenic effects. Separate mathematical models, such as the LeadSpread model developed by the DTSC (1999b), have been developed to evaluate these potential health concerns by estimating blood-lead levels resulting from contact with lead in various media (e.g., soil, air, food). The blood-lead level is of interest because most adverse human health effects are correlated in terms of blood-lead levels (e.g., a blood-lead level of “x” is associated with an increased incidence of adverse health effects). In contrast, risks and adverse health effects for other chemicals are correlated simply in terms of chemical intake.

The LeadSpread model was used to develop health-based screening levels for outdoor commercial/industrial worker and construction worker exposure to total lead in soil that are protective of benchmark blood-lead levels established by DTSC (1999b). Specifically, health-based screening levels were developed to be protective of a blood-lead level of concern of 10 micrograms per deciliter (µg/dL) in 99 percent of the population. The health-based screening levels were calculated using default background concentrations of lead in other environmental media (e.g., air, food, water) and exposure assumptions consistent with default parameters recommended by DTSC for use with LeadSpread with a few exceptions. For outdoor commercial/industrial workers, the soil-to-skin adherence factor used in the derivation of the other RBSLs was used in place of the default LeadSpread value; the default LeadSpread value is intended for adult residents. Similarly, for construction workers, values used in the derivation of the other RBSLs were used in place of the default LeadSpread values for exposed skin surface area and soil-to-skin adherence factor; the default LeadSpread values for these parameters are intended for commercial/industrial workers and adult residents, respectively. Finally, a soil ingestion rate equivalent to 50 percent of the ingestion rate used in the derivation of the other RBSLs was used for construction workers. This adjustment is consistent with recommended soil ingestion rates by DTSC for use with LeadSpread for other receptors (i.e., residents and workers). Attachments B-1 and B-2 present the LeadSpread calculations used in the derivation of the health-based screening levels for outdoor commercial/industrial workers and construction workers, respectively. The resulting health-based screening levels are summarized in Table B-7.

4.0 RISK-BASED SCREENING LEVELS FOR SOIL VAPOR

As described above, future exposure for the indoor commercial/industrial worker was assumed to be complete for chemicals migrating from subsurface soil into indoor air. Similarly, for the outdoor commercial/industrial worker and construction worker assumed to spend 100 percent of their time outdoors, future exposure was considered complete for chemicals migrating from subsurface soil into ambient air. RBSLs were developed for soil vapor concentrations to evaluate vapor migration to indoor or ambient air.

4.1 RISK-BASED SCREENING LEVELS FOR MIGRATION OF VOCS TO INDOOR AIR

This section presents the derivation of RBSLs for migration of VOCs in soil vapor to indoor air for indoor workers. When available, CHHSLs for chemicals in soil vapor at a commercial/ industrial site (OEHHA, 2005a) were used to estimate potential cancer risks and noncancer hazards based on inhalation of chemicals in indoor air for the indoor commercial/industrial worker. Construction workers are not considered to spend sufficient time indoors to warrant evaluation via this exposure pathway. The soil vapor CHHSLs used were those derived for current, common slab on grade building construction practices in California, in which a building foundation is separated from underlying soil by a layer of compacted, fine-grained cohesive soil and a layer of sub-slab gravel (OEHHA, 2005a). These soil vapor CHHSLs have been derived using the Johnson and Ettinger (1991) model to predict the transport of chemical vapors from soil into indoor air. Soil vapor CHHSLs were available for five of the seven volatile chemicals detected in soil vapor. Comparable RBSLs were developed for the two remaining volatile chemicals following the CHHSL methodology. The process followed to develop these RBSLs is based on the process presented in Appendix B of OEHHA guidance (2005a) and involves three consecutive steps:

1. *Calculation of target indoor air concentrations.* The equations used to develop the target indoor air concentrations for indoor commercial/industrial workers are presented below, as presented in Appendix B of OEHHA (2005a). Target indoor air concentrations were developed for both cancer risks (Equation 4) and noncancer adverse health effects (Equation 5):

$$C_{ia-risk} = \frac{TR \times ATca}{URF \times EF \times ED} \tag{4}$$

Where: $C_{ia\text{-}risk}$ = target indoor air concentration for cancer risks (µg/m^3)
URF = unit risk factor [(µg/m^3)$^{-1}$]
All other terms previously defined

$$C_{ia-haz} = \frac{THQ \times ATnc}{EF \times ED \times 1/RfC} \tag{5}$$

Where: $C_{ia\text{-}haz}$ = target indoor air concentration for noncancer hazard (µg/m3)
RfC = reference concentration (µg/m^3)
All other terms previously defined

Values of exposure parameters used in the target indoor air concentration calculations are listed in Table B-8. Exposure assumptions for the commercial/industrial workers were obtained from OEHHA (2005a) and U.S. EPA (1991). The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the target indoor air concentrations are presented in Table B-1.

2. *Use of the Johnson and Ettinger (1991) model to calculate chemical-specific, soil vapor-to-indoor air attenuation factors.* The attenuation factors provided by the Johnson and Ettinger (1991) model relate vapor concentrations in indoor air to vapor concentrations in the subsurface by accounting for the one-dimensional convective and diffusive mechanisms of vapor transport from the subsurface into indoor air. Consistent with OEHHA (2005a), the advanced Johnson and Ettinger model spreadsheets for subsurface vapor intrusion from soil parameterized by U.S. EPA were used to calculate the attenuation (Attachment C-1). Inputs to the advanced model spreadsheets include chemical properties, and unsaturated zone soil properties for sand from OEHHA, 2005a; conservative assumptions regarding other parameters (i.e., structural properties of the building) were based on default values in the model.

3. *Calculation of the soil vapor RBSLs.* The soil vapor RBSLs were estimated from the calculated target indoor air concentrations and attenuation factors using the following equation:

$$RBSL_{soil\ vapor-ia} = \frac{C_{ia}}{\alpha \times CF_{m3-L}} \quad (6)$$

Where: $RBSL_{soil\ vapor-ia}$ = risk-based screening level for soil vapor, indoor air (µg/L)
C_{ia} = target indoor air concentration (µg/m^3)
α = chemical-specific attenuation factor (unitless)
CF_{m3-L} = conversion factor from cubic meters to liters

The target commercial/industrial worker indoor air concentrations, attenuation factors, and soil vapor RBSLs estimated for the chemicals detected in soil vapor at the Site are presented in Table B-9.

4.2 RISK-BASED SCREENING LEVELS FOR SOIL VAPOR FOR MIGRATION OF VOCS TO AMBIENT AIR

RBSLs were developed for the chemical concentrations in soil vapor to be protective of potential commercial/industrial worker or construction worker exposure to the concentrations of these chemicals that may migrate into ambient air. The process followed to develop these RBSLs is comparable to the one outlined above for developing soil vapor RBSLs for indoor air exposure, but involves the use of different models to predict vapor flux and dispersion of chemicals from subsurface soil vapor to ambient air:

1. *Calculation of target ambient air concentrations for both cancer risks and noncancer adverse health effects.* The equations used to develop the target ambient air concentrations for outdoor commercial/industrial workers and construction workers are equivalent to the equations used to develop the target indoor air concentrations (Equations 4 and 5 above). Values of exposure parameters used in the target ambient air concentration calculations are listed in Tables B-3 and B-4 for the outdoor commercial/industrial workers and construction workers, respectively. The toxicity criteria for cancer risks and noncancer adverse health effects used in deriving the target ambient air concentrations are presented in Table B-1.

2. *Use of the X/Q Model to calculate subsurface vapor flux from the target ambient air concentrations.* The X/Q dispersion model presented in “Soil Screening Guidance: Users Guide and Technical Background Document” (U.S. EPA, 1996) allows for the prediction of ambient air concentrations of VOCs from a known or estimated subsurface vapor emission rate. The relationship established by the X/Q dispersion model of subsurface vapor flux to ambient air concentration was used to estimate the subsurface vapor emission rate associated with each target ambient air concentration:

$$E_i = \frac{C_{oa}}{X/Q} \tag{8}$$

Where: E_i = emission rate (µg/m^2-sec)
C_{oa} = target ambient air concentration (µg/m^3)
X/Q = Dispersion factor (mg/m^3 per mg/m^2-sec); calculated from the inverse dispersion factor as presented in supporting equations in Attachment A-1.

3. *Use of the VOC Emission Model to calculate soil vapor screening levels from estimated subsurface vapor flux.* After the subsurface vapor flux was estimated, the VOC Emission Model presented in "Soil Screening Guidance: Users Guide and Technical Background Document" (U.S. EPA, 1996) was used to estimate the soil vapor RBSL for ambient air exposures. First the total solute concentration associated with soil vapor was estimated as follows:

$$CT = \frac{E_i \times \sqrt{\pi \times Da \times T}}{2 \times Da \times CF_{m2-cm2}} \tag{9}$$

Where: CT = total solute concentration (µg/cm^3)
E_i = emission rate (µg/m^2-sec)
Da = chemical-specific effective diffusivity in soil pore space (cm^2/sec); calculated as presented in Attachment A-1, using site-specific assumptions presented in Attachment A-2 and chemical-specific parameters presented in Table B-2
T = exposure interval (sec) (equal to exposure duration)
CF_{m2-cm2} = conversion factor from square meters to square centimeters

The total solute concentration was then used to derive the soil vapor RBSL via the partitioning predicted by Henry's law:

$$RBSL_{soil\ vapor-oa} = \frac{CT}{[(pb \times Kd/H') + Pw/H' + Pa] \times CF_{cm3-L}} \tag{10}$$

Where: $RBSL_{soil\ vapor-oa}$ = risk-based screening level for soil vapor, ambient air (µg/L)
ρ_b = soil bulk density (g/cm^3)
Kd = soil-organic partition coefficient (cm^3/g)
H' = Henry's Law constant (unitless)
Pw = water-filled soil porosity (unitless)
Pa = air-filled soil porosity (unitless)
CF_{cm3-L} = conversion factor from cubic centimeters to liters
All other terms previously defined

The soil vapor RBSLs developed for commercial/industrial workers and construction workers for inhalation of ambient air are presented in Tables B-10 and B-11, respectively.

5.0 UNCERTAINTY ANALYSIS

Uncertainties are inherent in the development of RBSLs, and the use of these values to derive estimates of potential cancer risk and noncancer health hazards. In the development of screening levels, uncertainty arises from a lack of knowledge of toxicity and dose-response of the chemicals, and the extent to which an individual will be exposed to those chemicals (U.S. EPA, 1989). Assumptions are made based on information presented in the scientific literature or professional judgment. While some assumptions have significant scientific basis, others have less scientific basis. The assumptions that introduce the greatest amount of uncertainty in the development of RBSL are discussed below, consistent with U.S. EPA requirements (1989). Uncertainties associated with other aspects of the risk assessment process, such as site characterization, data evaluation, and the use of screening levels in risk characterization, are presented in the report.

5.1 ENVIRONMENTAL FATE AND TRANSPORT

Fate and transport models were used in the development of RBSLs to predict the migration of vapors into indoor and ambient air. While some site-specific conditions were incorporated into the analysis, the models are screening-level models, which typically are conservative and predict concentrations that overestimate risk. For example, biodegradation of petroleum constituents in the vadose zone is not considered. In addition, assumptions about future building design have been incorporated into the indoor air model (e.g., slab-on-grade foundations). The development of RBSLs is therefore dependent on future building conditions being consistent with those included in the model.

5.2 EXPOSURE ASSUMPTIONS AND PARAMETERS

The exposure parameters used to derive the RBSLs are based on reasonable maximum exposure (RME), which is defined by U.S. EPA as the highest exposure that could reasonably be expected to occur for a given exposure pathway at a site (U.S. EPA, 1989). The exposure parameters associated with a RME scenario are therefore highly conservative. For example, under RME conditions, it is assumed that a commercial/industrial worker is present on-site for 250 days/year for 25 years. The use of such upper-bound estimates in the development of RBSL most likely results in overly protective values.

5.3 TOXICITY CRITERIA

One of the largest sources of uncertainty in any risk assessment is associated with the scientific community's limited understanding of the toxicity of most chemicals in humans following exposure to the low concentrations generally encountered in the environment. The majority of available toxicity data are from animal studies, which are then extrapolated using mathematical models or multiple uncertainty factors to generate toxicity criteria used to predict what might occur in humans. Sources of conservatism in the toxicity criteria used in this evaluation include:

- the use of conservative methods and assumptions to extrapolate from high dose animal studies to predict the possible response in humans at exposure levels far below those administered to animals;
- the assumption that chemicals considered to be carcinogens do not have thresholds (i.e., for all doses greater than zero, some risk is assumed to be present); and
- the fact that epidemiological studies (i.e., human exposure studies) are limited and are not generally considered in a quantitative manner in deriving toxicity values.

The toxicity criteria used in the development of RBSLs were developed using different methods. The noncarcinogenic criteria (i.e., oral and inhalation RfDs) incorporate multiple safety factors to account for limitations in the quality or quantity of available data (e.g., animal data in lieu of human data). These safety factors are applied without regard to available data on the true likelihood of a variation in human response. Therefore, RfDs may be hundreds of times smaller than doses that would actually cause adverse health effects. This purposeful bias in the development of RfDs overestimates the actual potential for noncarcinogenic health risks for these chemicals.

The carcinogenic toxicity criteria (i.e., oral and inhalation CSFs) also are developed using techniques that purposefully bias the criteria toward health conservatism. For example, most CSFs are based on the premise that cancer data from high dose animal studies will predict cancer response in humans at dose levels thousands of times lower. The process also assumes that the carcinogenicity of a chemical in an animal model is representative of the response in humans. Finally, the statistical techniques used by regulatory agencies to extrapolate data from animals to human exposures generally assume that the dose-response curve is linear and that the 95% upper confidence limit of the mean of the slope is representative of the chemical's carcinogenic potency. In aggregate, these assumptions overestimate the actual risk estimates such that they are unlikely to be higher, but could be considerably lower and, in fact, could be non-existent.

A second uncertainty associated with toxicity criteria is the unavailability of RfDs or CSFs for all chemicals at the Site. RBSLs can only be derived for those chemicals for which the relevant toxicity criteria are available. In the absence of data for the inhalation route of exposure, the CSF or RfD for the oral route for these chemicals was used in the evaluation. As a result, the RBSLs for these chemicals may be over- or underestimated. Further, the use of oral toxicity values to assess the dermal pathway introduces additional uncertainty into the results; RBSLs may be overestimated or underestimated using this approach as well. Lastly, in just a few cases, surrogate chemicals were used to represent the toxicity of other chemicals. While the selection and use of surrogates for toxicity criteria is not ideal, the surrogates selected for use in the HHRA were all very closely structurally related to the contaminants they were chosen to represent. A lack of a toxicity criterion would otherwise remain a data gap. The degree of uncertainty contributed by the use of surrogates in this manner is unknown but is not expected to result in significant underestimates of risk.

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TABLES

TABLE B-1
TOXICITY CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Surrogate	Carcinogenic Toxicity											Chronic Noncarcinogenic Criteria								
			Oral				Dermal	Inhalation						Oral			Dermal	Inhalation				
			OEHHA[1] CSFo	U.S. EPA[2] CSFo	Other[3] CSFo	Final[4] CSFo	CSFd[5]	OEHHA[1] URF	OEHHA[1] CSFi	U.S. EPA[2] URF	Other[3] CSFi	Final CSFi or URF[4]		U.S. EPA[2] RfDo	Other[3] RfDo	Final[6] RfDo	RfDd[5]	OEHHA REL[1]	U.S. EPA[2] RfC	Other[3] RfDi	Final RfDi or RfC[4]	
			$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(\mu g/m^3)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(\mu g/m^3)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(mg/kg\text{-}day)^{-1}$	$(\mu g/m^3)^{-1}$	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)	$(\mu g/m^3)$	$(\mu g/m^3)$	(mg/kg-day)	(mg/kg-day)	$(\mu g/m^3)$
11141165	Aroclor-1232	"high-risk" PCBs (slope factors)	NA	2.00E+00	NA	2.00E+00	2.00E+00	5.70E-04	2.00E+00	1.00E-04	NA	2.00E+00	5.70E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
12672296	Aroclor-1248	"high-risk" PCBs (slope factors)	NA	2.00E+00	NA	2.00E+00	2.00E+00	5.70E-04	2.00E+00	1.00E-04	NA	2.00E+00	5.70E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
11097691	Aroclor-1254	"high-risk" PCBs (slope factors)	NA	2.00E+00	NA	2.00E+00	2.00E+00	5.70E-04	2.00E+00	1.00E-04	NA	2.00E+00	5.70E-04	2.00E-05	NA	2.00E-05	2.00E-05	NA	NA	2.00E-05 r	2.00E-05	7.00E-02
11096825	Aroclor-1260	"high-risk" PCBs (slope factors)	NA	2.00E+00	NA	2.00E+00	2.00E+00	5.70E-04	2.00E+00	1.00E-04	NA	2.00E+00	5.70E-04	NA	NA	NA	NA	NA	NA	NA	NA	NA
7440382	Arsenic		9.45E+00	1.50E+00	NA	9.45E+00	9.45E+00	3.30E-03	1.20E+01	4.30E-03	NA	1.20E+01	3.30E-03	3.00E-04	NA	3.00E-04	3.00E-04	3.00E-02	NA	NA	8.57E-06	3.00E-02
7440439	Cadmium		NA	NA	NA	NA	NA	4.20E-03	1.50E+01	1.80E-03	NA	1.50E+01	4.20E-03	5.00E-04	NA	5.00E-04	5.00E-04	2.00E-02	NA	NA	5.71E-06	2.00E-02
7440508	Copper		NA	NC	NA	NC	NC	NA	NA	NC	NA	NC	NC	NA	3.70E-02 h-u	3.70E-02	3.70E-02	NA	NA	3.70E-02 r	3.70E-02	1.30E+02
7439976	Mercury	Mercuric chloride (oral reference dose)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.00E-04	NA	3.00E-04	3.00E-04	9.00E-02	NA	NA	2.57E-05	9.00E-02
7440666	Zinc		NA	NC	NA	NC	NC	NA	NA	NC	NA	NC	NC	3.00E-01	NA	3.00E-01	3.00E-01	NA	NA	3.00E-01 r	3.00E-01	1.05E+03
100414	Ethylbenzene		1.10E-02	NC	NA	1.10E-02	1.10E-02	2.50E-06	8.75E-03	NC	NA	8.75E-03	2.50E-06	1.00E-01	NA	1.00E-01	1.00E-01	2.00E+03	1.00E+03	NA	5.71E-01	2.00E+03
127184	Tetrachloroethylene (PCE)		5.40E-01	NA	NA	5.40E-01	5.40E-01	5.90E-06	2.10E-02	NA	NA	2.10E-02	5.90E-06	1.00E-02	NA	1.00E-02	1.00E-02	3.50E+01	NA	NA	1.00E-02	3.50E+01
108883	Toluene		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.00E-02	NA	8.00E-02	8.00E-02	3.00E+02	5.00E+03	NA	8.57E-02	3.00E+02
79016	Trichloroethylene (TCE)		1.30E-02	NA	NA	1.30E-02	1.30E-02	2.00E-06	7.00E-03	NA	NA	7.00E-03	2.00E-06	NA	3.00E-04 n	3.00E-04	3.00E-04	6.00E+02	NA	1.00E-02 n	1.71E-01	6.00E+02
108383	m,p-Xylenes	Xylenes (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.00E-01	NA	2.00E-01	2.00E-01	7.00E+02	1.00E+02	NA	2.00E-01	7.00E+02
95476	o-Xylene	Xylenes (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.00E-01	NA	2.00E-01	2.00E-01	7.00E+02	1.00E+02	NA	2.00E-01	7.00E+02

Notes:
1. Office of Environmental Health Hazard Assessment (OEHHA), 2008, Toxicity Criteria Database; or OEHHA, 2005b, Chronic Reference Exposure Levels
2. U.S. EPA, 2008, Integrated Risk Information System (IRIS) database.
3. Other U.S. EPA toxicity criteria, as recommended or provided in OEHHA, 2005a, Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, or U.S. EPA, 2004b, Region 9 Preliminary Remediation Goals (PRGs), as noted:
   - h-u Toxicity value from HEAST, as provided in U.S. EPA, 2004b, Region 9 Preliminary Remediation Goals
   - n Toxicity value from NCEA, as provided in U.S. EPA, 2004b, Region 9 Preliminary Remediation Goals
   - r Toxicity value derived via route-extrapolation, as recommended in U.S. EPA, 2004b, Region 9 Preliminary Remediation Goals
4. The final criteria is selected, in order, from OEHHA, IRIS, and then other U.S. EPA toxicity criteria sources.
5. In the derivation of dermal toxicity factors, gastrointestinal absorption efficiency was assumed to be 100 percent for all chemicals.
6. The final oral reference dose is selected, in order, from IRIS and then other U.S. EPA toxicity criteria sources.

Abbreviations:
CAS No. = chemical abstract service number
CSFd = dermal cancer slope factor
CSFi = inhalation cancer slope factor
CSFo = oral cancer slope factor
HEAST = Health Effects Assessment Summary Tables (U.S. EPA 1997)
mg/kg-day = milligrams per kilogram per day
$\mu g/m^3$ = micrograms per cubic meter
NA = not available
NC = noncarcinogenic
NCEA = National Center for Environmental Assessment
OEHHA = Office of Environmental Health Hazard Assessment
RfC = reference concentration
RfDd = dermal reference dose
RfDi = inhalation reference dose
RfDo = oral reference dose
REL = reference exposure level
URF = unit risk factor
U.S. EPA = United States Environmental Protection Agency

TABLE B-2
PHYSICOCHEMICAL CONSTANTS FOR CHEMICALS OF POTENTIAL CONCERN
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Log Octanol-Water Coefficient (log Kow) (unitless)	Ref	Henry's Law Constant (H) (atm-m^3/mole)	Ref	Diffusivity in Air (D_i) (cm^2/sec)	Ref	Diffusivity in Water (Dw) (cm^2/sec)	Ref	Organic Carbon Partition Coefficient (Koc) (L/kg)	Ref	Molecular Weight (MW) (g/mole)	Ref	Dermal Soil Absorption (ABSds) --	Ref
11141165	Aroclor-1232	3.20	1	8.6E-04	1	NA	--	7.2E-06	1	6.8E+02	1	221	1	0.14	8
12672296	Aroclor-1248	6.06	1	2.9E-03	1	NA	--	6.6E-06	1	4.4E+05	1	288	1	0.14	8
11097691	Aroclor-1254	6.04	1	2.0E-03	7	1.6E-02	5	5.0E-06	5	2.0E+05	5	327	1	0.14	8
11096825	Aroclor-1260	6.51	1	1.9E-04	7	3.7E-02	5	5.3E-06	5	2.9E+05	5	370	1	0.14	8
7440382	Arsenic	NA	--	NA	--	NA	--	NA	--	NA	--	75	4	0.04	2
7440439	Cadmium	NA	--	NA	--	NA	--	NA	--	NA	--	112	4	0.001	8
7440508	Copper	NA	--	NA	--	NA	--	NA	--	NA	--	64	4	0.01	3
7439976	Mercury	NA	--	1.1E-02	6	3.1E-02	6	6.3E-06	6	5.2E+01	6	200.59	6	0.1	3
7440666	Zinc	NA	--	NA	--	NA	--	NA	--	NA	--	65	4	0.01	3
100414	Ethylbenzene	3.14	3	7.9E-03	6	7.5E-02	6	7.8E-06	6	3.6E+02	6	106.17	6	0.1	3
127184	Tetrachloroethylene	2.67	3	1.8E-02	6	7.2E-02	6	8.2E-06	6	1.6E+02	6	165.83	6	0.1	3
108883	Toluene	2.75	3	6.6E-03	6	8.7E-02	6	8.6E-06	6	1.8E+02	6	92.14	6	0.1	3
79016	Trichloroethylene (TCE)	2.71	3	1.0E-02	6	7.9E-02	6	9.1E-06	6	1.7E+02	6	131.39	6	0.1	3
108383	m,p-Xylenes	3.20	1	7.6E-03	6	7.7E-02	6	8.4E-06	6	3.9E+02	6	106.17	6	0.1	3
95476	o-Xylene	3.13	1	5.2E-03	6	8.7E-02	6	1.0E-05	6	3.6E+02	6	106.17	6	0.1	3

Notes:
1. Montgomery, J.H., 2000, Groundwater Chemicals Desk Reference
2. OEHHA, 2005a, Human Exposure-Based Screening Levels Developed to Aid Estimation of Cleanup Costs for Contaminated Soil
3. DTSC, 1999a, Preliminary Endangerment Assessment Guidance Manual
4. Budavari et al., 1996, Merck Index
5. U.S. EPA, 2000, User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion Into Buildings (Revised), December
6. U.S. EPA, 2003, User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion Into Buildings (Revised), December
7. Pennsylvania Department of Environmental Protection, 2007, Chemical and Physical Property Database
8. U.S. EPA, 2004a, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final.

Abbreviations:
atm-m^3/mole = atmospheres - cubic meter per mole
cm^2/sec = square centimeters per second
g/mole = grams per mole
L/kg = liters per kilogram
NA = not available
Ref = reference
-- = not applicable

TABLE B-3

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR OUTDOOR COMMERCIAL/INDUSTRIAL WORKERS

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure	
GENERAL EXPOSURE PARAMETERS			
Exposure Frequency (EF)	days/year	Value:	250
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991
Exposure Duration (ED)	years	Value:	25
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991
Body Weight (BW)	kg	Value:	70
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991
Averaging Time (AT)	days	Value:	25,550 (carcinogens) 9,125 (noncarcinogens)
		Rationale:	OEHHA,2005a; U.S. EPA, 1991
PATHWAY-SPECIFIC PARAMETERS			
Incidental Soil Ingestion			
Soil Ingestion Rate (IR_s)	mg/day	Value:	100
		Rationale:	OEHHA, 2005a
Dermal Contact with Soil			
Exposed Skin Surface Area (SA_s)	cm^2/day	Value:	3,300
		Rationale:	OEHHA, 2005a
Soil-to-Skin Adherence Factor (SAF)	mg/cm^2	Value:	0.2
		Rationale:	OEHHA, 2005a
Absorption Fraction (ABSds)	unitless	Value:	Chemical-specific
		Rationale:	see Table B-2

TABLE B-3

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR OUTDOOR COMMERCIAL/INDUSTRIAL WORKERS

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure
Inhalation of Suspended Soil Particulates		
Inhalation Rate (IHR_a)	m^3/hr	Value: 2.5 Rationale: OEHHA, 2005a
Particulate Emission Factor (PEF)	m^3/kg	Value: $1.32x10^9$ Rationale: OEHHA, 2005a; U.S. EPA, 1996
Exposure Time (ET)	hours	Value: 8 Rationale: OEHHA, 2005a; U.S. EPA, 1991
Inhalation of Vapors in Outdoor Air		
Inhalation Rate (IHR_a)	m^3/hr	Value: 2.5 Rationale: OEHHA, 2005a
Exposure Time (ET)	hours	Value: 8 Rationale: OEHHA, 2005a; U.S. EPA, 1991

Abbreviations:
cm^2/day = centimeters squared per day
kg = kilograms
m^3/hr = cubic meters per hour
m^3/kg = cubic meters per kilogram
mg/cm^2 = milligrams per squared centimeters
mg/day = milligrams per day

TABLE B-4

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR CONSTRUCTION WORKERS

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure
GENERAL EXPOSURE PARAMETERS		
Exposure Frequency (EF)	days/year	Value: 250 Rationale: U.S. EPA, 2002
Exposure Duration (ED)	years	Value: 1 Rationale: U.S. EPA, 2002
Body Weight (BW)	kg	Value: 70 Rationale: DTSC, 1996; U.S. EPA, 1991, U.S. EPA, 2002
Averaging Time (AT)	days	Value: 25,550 (carcinogens) 365 (noncarcinogens) Rationale: DTSC, 1996; U.S. EPA, 1991, U.S. EPA, 2002
Pathway-Specific Parameters		
Incidental Soil Ingestion		
Soil Ingestion Rate (IR_s)	mg/day	Value: 330 Rationale: U.S. EPA, 2002
Dermal Contact with Soil		
Exposed Skin Surface Area (SA_s)	cm^2/day	Value: 3,300 Rationale: U.S. EPA, 2002
Soil-to-Skin Adherence Factor (SAF)	mg/cm^2	Value: 0.3 Rationale: U.S. EPA, 2002
Absorption Fraction (ABSds)	unitless	Value: Chemical-specific Rationale: see Table B-2

TABLE B-4

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR CONSTRUCTION WORKERS

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure
Inhalation of Vapors in Ambient Air		
Inhalation Rate (IHR_a)	m^3/hr	Value: 2.5 Rationale: U.S. EPA, 2002
Exposure Time (ET)	hours	Value: 8 Rationale: DTSC, 1996; U.S. EPA, 1991; Standard work day
Inhalation of Suspended Soil Particulates		
Particulate Emission Factor (PEF)	m^3/kg	Value: $2.0x10^7$ Rationale: DTSC, 1999a; corresponds to the PM10 Ambient Air Quality Standard of 50 $\mu g/m^3$; also consistent with U.S. EPA, 2002b, recommended PEF for construction activities other than unpaved road traffic ($3.6x10^7$ m^3/kg)
Inhalation Rate (IHR_a)	m^3/hr	Value: 2.5 Rationale: U.S. EPA, 2002
Exposure Time (ET)	hours	Value: 8 Rationale: DTSC, 1996; U.S. EPA, 1991; Standard work day

<u>Abbreviations</u>:
cm^2/day = centimeters squared per day
kg = kilograms
m^3/hr = cubic meters per hour
m^3/kg = cubic meters per kilogram
mg/cm^2 = milligrams per squared centimeters
mg/day = milligrams per day

TABLE B-5
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL --
OUTDOOR COMMERCIAL/INDUSTRIAL WORKER
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Oral Cancer Slope Factor (CSF_o) (mg/kg-day)$^{-1}$	Dermal Cancer Slope Factor (CSFd) (mg/kg-day)$^{-1}$	Inhalation Cancer Slope Factor (CSF_i) (mg/kg-day)$^{-1}$	Oral Reference Dose (RfDo) (mg/kg-day)	Dermal Reference Dose (RfDd) (mg/kg-day)	Inhalation Reference Dose (RfDi) (mg/kg-day)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Henry's Law Constant (atm-m^3/mole)	VOC? [2]	Soil RBSL[1] -- Outdoor Commercial/Industrial Worker: Cancer (mg/kg)	Noncancer (mg/kg)
Polychlorinated Biphenyls (PCBs)													
11141165	Aroclor-1232 [3]	2	2	2	NA	NA	NA	0.14	2.2E+02	8.6E-04	No	7.4E-01	--
12672296	Aroclor-1248 [3]	2	2	2	NA	NA	NA	0.14	2.9E+02	2.9E-03	No	7.4E-01	--
11097691	Aroclor-1254 [3]	2	2	2	2.00E-05	2.00E-05	2.00E-05	0.14	3.3E+02	2.0E-03	No	7.4E-01	1.1E+01
11096825	Aroclor-1260 [3]	2	2	2	NA	NA	NA	0.14	3.7E+02	1.9E-04	No	7.4E-01	--
Metals													
7440382	Arsenic	9.45	9.45	12	3.00E-04	3.00E-04	8.57E-06	0.04	7.5E+01	NA	No	2.4E-01	2.4E+02
7440439	Cadmium [4]	NA	NA	15	5.00E-04	5.00E-04	5.71E-06	0.001	1.1E+02	NA	No	1.3E+03	5.0E+02
7440508	Copper [5]	NC	NC	NC	3.70E-02	3.70E-02	3.70E-02	0.01	6.4E+01	NA	No	NC	3.5E+04
7439976	Mercury	NA	NA	NA	3.00E-04	3.00E-04	2.57E-05	0.1	2.0E+02	1.1E-02	No	--	1.8E+02
7440666	Zinc [6]	NC	NC	NC	3.00E-01	3.00E-01	3.00E-01	0.01	6.5E+01	NA	No	NC	2.9E+05
Volatile Organic Compounds (VOCs) [7]													
100414	Ethylbenzene	0.011	0.011	0.00875	1.00E-01	1.00E-01	5.71E-01	0.1	1.1E+02	7.9E-03	Yes	1.6E+02	6.2E+04
127184	Tetrachloroethylene (PCE)	0.54	0.54	0.021	1.00E-02	1.00E-02	1.00E-02	0.1	1.7E+02	1.8E-02	Yes	3.2E+00	6.2E+03
108883	Toluene	NA	NA	NA	8.00E-02	8.00E-02	8.57E-02	0.1	9.2E+01	6.6E-03	Yes	--	4.9E+04
79016	Trichloroethylene (TCE)	0.013	0.013	0.007	3.00E-04	3.00E-04	1.71E-01	0.1	1.3E+02	1.0E-02	Yes	1.3E+02	1.8E+02
108383	m/p-Xylenes	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	7.6E-03	Yes	--	1.2E+05
95476	o-Xylene	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	5.2E-03	Yes	--	1.2E+05

Notes:

1. Risk-based screening levels (RBSL) calculated using the methodology presented by OEHHA, 2005a, Human-Exposed-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, January.
2. Chemicals identified as a volatile organic compound (VOC) if the molecular weight is less than 200 g/mole and the Henry's Law Constant is greater than $1x10^{-5}$ atm-m^3/mole. A particulate emission factor (PEF) of $1.316x10^9$ m^3/kg is used in the derivation of RBSLs for all non-volatile chemicals.
3. Cancer RBSLs calculated for PCBs deviate from, and are less conservative than, the number presented in OEHHA (2005a), 0.3 mg/kg. The use of the U.S. EPA CSF of 2 (mg/kg-day)$^{-1}$ instead of the OEHHA CSF of 5 (mg/kg-day)$^{-1}$ results in the less conservative number (0.74 mg/kg). However, this correction is considered appropriate; the 5 (mg/kg-day)$^{-1}$ CSF is considered outdated by OEHHA (2005c).
4. Cancer RBSL calculated for cadmium deviates from, and is less conservative than, the number presented in OEHHA (2005a), 7.5 mg/kg. The 7.5 mg/kg screening level developed by OEHHA was derived using an oral CSF of 0.38 (mg/kg-day)$^{-1}$ (OEHHA, 2005a). However, subsequent to the development of the 7.5 mg/kg screening level, OEHHA has removed the oral CSF from the Toxicity Criteria Database (OEHHA, 2008), having determined that "there is insufficient information on the carcinogenicity of cadmium via the oral route" (OEHHA, 2007).

TABLE B-5
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL --
OUTDOOR COMMERCIAL/INDUSTRIAL WORKER
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

5. Noncancer RBSL calculated for copper deviates from, and is more conservative than, the number presented in OEHHA (2005a), 38,000 mg/kg. The more conservative noncancer RBSL, 35,000 mg/kg, results from using the reference dose provided in HEAST, 0.037 mg/kg-day (U.S. EPA, 1997). A slightly less conservative number is presented in OEHHA (2005a) from rounding the HEAST reference dose to one significant figure, 0.04 mg/kg-day, and using this value in the screening level calculation.
6. Noncancer RBSL calculated for zinc deviates from, and is less conservative than, the number presented in OEHHA (2005a). The calculated RBSL is considered appropriate for the purposes of estimating noncancer hazards; the lower number presented in OEHHA (2005a), 100,000 mg/kg, is based on the maximum concentration allowed, not toxicity.
7. Inhalation pathways not incorporated into the development of soil RBSLs for VOCs. Volatilization of chemicals from the subsurface to ambient air evaluated using RBSLs developed for soil vapor (Table B-10).

Abbreviations:
- atm-m^3/mole = atmospheres - cubic meter per mole
- CAS No. = chemical abstract service number
- g/mole = grams per mole
- mg/kg = milligrams per kilogram
- mg/kg-day = milligrams per kilogram - day
- NA = not available
- NC = noncarcinogenic
- -- = not applicable

Equations:

$$RBSL_{soil-risk} = \frac{TR \times BW \times AT_{ca}}{ED \times EF \times \left[\left(\frac{IR_S \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{SAs \times SAF \times ABS \times CSF_o}{CF_{kg-mg}}\right) + \left(\frac{IHR_a \times ET \times CSF_i}{PEF}\right)\right]}$$

$$RBSL_{soil-haz} = \frac{THQ \times BW \times AT_{nc}}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IRS}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_o} \times \frac{SAs \times SAF \times ABS}{CF_{kg-mg}}\right) + \left(\frac{1}{RfD_i} \times \frac{IHR_a \times ET}{PEF}\right)\right]}$$

TABLE B-6
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL --
CONSTRUCTION WORKER
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Oral Cancer Slope Factor (CSF_o) $(mg/kg\text{-}d)^{-1}$	Dermal Cancer Slope Factor (CSFd) $(mg/kg\text{-}d)^{-1}$	Inhalation Cancer Slope Factor (CSF_i) $(mg/kg\text{-}d)^{-1}$	Oral Reference Dose (RfDo) (mg/kg-d)	Dermal Reference Dose (RfDd) (mg/kg-d)	Inhalation Reference Dose (RfDi) (mg/kg-d)	Absorption Factor ABS (--)	Molecular Weight (g/mole)	Henry's Law Constant $(atm\text{-}m^3/mole)$	VOC? [2]	Soil RBSL[1] -- Construction Worker Cancer (mg/kg)	Soil RBSL[1] -- Construction Worker Noncancer (mg/kg)
Polychlorinated Biphenyls (PCBs)													
11141165	Aroclor-1232	2	2	2	NA	NA	NA	0.14	2.2E+02	8.6E-04	No	7.6E+00	--
12672296	Aroclor-1248	2	2	2	NA	NA	NA	0.14	2.9E+02	2.9E-03	No	7.6E+00	--
11097691	Aroclor-1254	2	2	2	2.00E-05	2.00E-05	2.00E-05	0.14	3.3E+02	2.0E-03	No	7.6E+00	4.4E+00
11096825	Aroclor-1260	2	2	2	NA	NA	NA	0.14	3.7E+02	1.9E-04	No	7.6E+00	--
Metals													
7440382	Arsenic	9.45	9.45	12	3.00E-04	3.00E-04	8.57E-06	0.04	7.5E+01	NA	No	2.0E+00	7.6E+01
7440439	Cadmium	NA	NA	15	5.00E-04	5.00E-04	5.71E-06	0.001	1.1E+02	NA	No	4.8E+02	1.2E+02
7440508	Copper	NC	NC	NC	3.70E-02	3.70E-02	3.70E-02	0.01	6.4E+01	NA	No	NC	1.1E+04
7439976	Mercury	NA	NA	NA	3.00E-04	3.00E-04	2.57E-05	0.1	2.0E+02	1.1E-02	No	--	7.0E+01
7440666	Zinc	NC	NC	NC	3.00E-01	3.00E-01	3.00E-01	0.01	6.5E+01	NA	No	NC	9.0E+04
Volatile Organic Compounds (VOCs) [3]													
100414	Ethylbenzene	0.011	0.011	0.00875	1.00E-01	1.00E-01	5.71E-01	0.1	1.1E+02	7.9E-03	Yes	1.5E+03	2.4E+04
127184	Tetrachloroethylene (PCE)	0.54	0.54	0.021	1.00E-02	1.00E-02	1.00E-02	0.1	1.7E+02	1.8E-02	Yes	3.1E+01	2.4E+03
108883	Toluene	NA	NA	NA	8.00E-02	8.00E-02	8.57E-02	0.1	9.2E+01	6.6E-03	Yes	--	1.9E+04
79016	Trichloroethylene (TCE)	0.013	0.013	0.007	3.00E-04	3.00E-04	1.71E-01	0.1	1.3E+02	1.0E-02	Yes	1.3E+03	7.1E+01
108383	m/p-Xylenes	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	7.6E-03	Yes	--	4.8E+04
95476	o-Xylene	NA	NA	NA	2.00E-01	2.00E-01	2.00E-01	0.1	1.1E+02	5.2E-03	Yes	--	4.8E+04

Notes:
1. Risk-based screening levels (RBSL) calculated using the methodology presented by OEHHA, 2005a, Human-Exposed-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, January.
2. Chemicals identified as a volatile organic compound (VOC) if the molecular weight is less than 200 g/mole and the Henry's Law Constant is greater than $1x10^{-5}$ $atm\text{-}m^3/mole$. A particulate emission factor (PEF) of $2.0x10^7$ m^3/kg is used in the derivation of RBSLs for all non-volatile chemicals.
3. Inhalation pathways not incorporated into the development of soil RBSLs for VOCs. Volatilization of chemicals from the subsurface to ambient air evaluated using RBSLs developed for soil vapor (Table B-11).

TABLE B-6
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL --
CONSTRUCTION WORKER
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Abbreviations:

- atm-m^3/mole = atmospheres - cubic meter per mole
- CAS No. = chemical abstract service number
- g/mole = grams per mole
- µg/kg = micrograms per kilogram
- mg/kg = milligrams per kilogram
- mg/kg-day = milligrams per kilogram - day
- NA = not available
- NC = noncarcinogenic
- -- = not applicable

Equations:

$$RBSL_{soil-risk} = \frac{TR \times BW \times AT_{ca}}{ED \times EF \times \left[\left(\frac{IR_S \times CSF_o}{CF_{kg-mg}} \right) + \left(\frac{SAs \times SAF \times ABS \times CSF_o}{CF_{kg-mg}} \right) + \left(\frac{IHR_a \times ET \times CSF_i}{PEF} \right) \right]}$$

$$RBSL_{soil-haz} = \frac{THQ \times BW \times AT_{nc}}{ED \times EF \times \left[\left(\frac{1}{RfD_o} \times \frac{IRS}{CF_{kg-mg}} \right) + \left(\frac{1}{RfD_o} \times \frac{SAs \times SAF \times ABS}{CF_{kg-mg}} \right) + \left(\frac{1}{RfD_i} \times \frac{IHR_a \times ET}{PEF} \right) \right]}$$

TABLE B-7

HEALTH-BASED SCREENING LEVELS FOR LEAD IN SOIL

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Scenario	Screening Level[1] (mg/kg)
Construction Worker	980
Outdoor Commercial/Industrial Worker	3300

Notes:

1. Corresponds to blood lead levels less than the 10 micrograms per deciliter (µg/dL) level of concern.

Abbreviations:

mg/kg = milligrams per kilogram

TABLE B-8

EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING LEVELS FOR INDOOR COMMERCIAL/INDUSTRIAL WORKERS

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure (RME)	
GENERAL EXPOSURE PARAMETERS			
Exposure Frequency (EF)	days/year	Value:	250
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991
Exposure Duration (ED)	years	Value:	25
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991
Body Weight (BW)	kg	Value:	70
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991
Averaging Time (AT)	days	Value:	25,550 (carcinogens) 9,125 (noncarcinogens)
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991
PATHWAY-SPECIFIC PARAMETERS			
Inhalation of Vapors in Indoor Air			
Inhalation Rate (IHR_a)	m^3/hr	Value:	2.5
		Rationale:	OEHHA, 2005a
Exposure Time (ET)	hours	Value:	8
		Rationale:	OEHHA, 2005a; U.S. EPA, 1991

Abbreviations:
kg = kilograms
m^3/hr = cubic meters per hour

TABLE B-9
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL VAPOR -- INDOOR COMMERCIAL/INDUSTRIAL WORKER
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Inhalation Toxicity Criteria		Soil Vapor RBSL -- Indoor Commercial/Industrial Worker					
				Cancer			Noncancer		
		URF $(\mu g/m^3)^{-1}$	RfC $(\mu g/m^3)$	Indoor Air $(\mu g/m^3)$	alpha[2] (unitless)	Soil Vapor (µg/L)	Indoor Air $(\mu g/m^3)$	alpha[2] (unitless)	Soil Vapor (µg/L)
67663	Chloroform	5.3E-06	3.0E+02	7.71E-01	5.47E-04	1.41E+00	4.4E+02	5.5E-04	8.0E+02
75354	1,1-Dichloroethylene	NA	7.0E+01	--	5.03E-04	--	1.0E+02	5.0E-04	2.0E+02
127184	Tetrachloroethylene (PCE)	5.9E-06	3.5E+01	6.93E-01	4.39E-04	1.58E+00	5.1E+01	4.4E-04	1.2E+02
108883	Toluene	NA	3.0E+02	--	4.93E-04	--	4.4E+02	4.9E-04	8.9E+02
71556	1,1,1-Trichloroethane	NC	2.2E+03	NC	4.61E-04	NC	3.2E+03	4.6E-04	7.0E+03
79016	Trichloroethylene (TCE)	2.0E-06	6.0E+02	2.04E+00	4.65E-04	4.39E+00	8.8E+02	4.7E-04	1.9E+03
108383	m,p-Xylenes	NA	7.0E+02	--	4.31E-04	--	1.0E+03	4.6E-04	2.2E+03

Notes:
1. Risk-based screening levels (RBSL) calculated using the methodology outlined by OEHHA, 2005a, Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil, January.
2. Chemical-specific alphas calculated using the Johnson and Ettinger Model and default parameters for existing commercial/industrial buildings as outlined by OEHHA (2005a). Johnson and Ettinger Model outputs are presented in Attachment C-1.

Abbreviations:
- CAS No. = chemical abstract service number
- mg/L = micrograms per liter
- $\mu g/m^3$ = micrograms per cubic meter
- NA = not available
- NC = noncarcinogenic
- RfC = reference concentration
- URF = unit risk factor
- -- = not applicable

Equations:

$$C_{ia-risk} = \frac{TR \times ATca}{URF \times EF \times ED}$$

$$C_{ia-haz} = \frac{THQ \times ATnc}{EF \times ED \times 1/RfC}$$

$$RBSL_{soil\ vapor-ia} = \frac{C_{ia}}{\alpha \times CF_{m3-L}}$$

TABLE B-10
RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL VAPOR --
OUTDOOR COMMERCIAL/INDUSTRIAL WORKER EXPOSURE TO AMBIENT AIR
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Inhalation Toxicity Criteria		Diffusivity in Air (Di) (cm^2/sec)	Diffusivity in Water (Dw) (cm^2/sec)	Henry's Law Constant (H) (atm-m^3/mole)	Dimensionless Henry's Law Constant (H') (unitless)	Organic Carbon Partition Coefficient (Koc) (L/kg)	Soil-Organic Partition Coefficient (Kd) (cm^3/g)	Effective Diffusivity (Da) (cm^2/sec)	Soil Vapor RBSL -- Outdoor Commercial/Industrial Worker							
											Cancer				Noncancer			
		URF ($\mu g/m^3$)$^{-1}$	RfC ($\mu g/m^3$)								Ambient Air Screening Level ($\mu g/m^3$)	Emission Rate (Ei) ($\mu g/m^2$-sec)	Total Solute Concentration (CT) ($\mu g/cm^3$)	Soil Vapor Screening Level (µg/L)	Ambient Air Screening Level ($\mu g/m^3$)	Emission Rate (Ei) ($\mu g/m^2$-sec)	Total Solute Concentration (CT) ($\mu g/cm^3$)	Soil Vapor Screening Level (µg/L)
67663	Chloroform	5.3E-06	3.0E+02	1.04E-01	1.00E-05	3.66E-03	1.50E-01	3.98E+01	7.96E-02	1.07E-02	7.71E-01	4.55E-02	1.09E+00	7.0E+02	4.4E+02	2.6E+01	6.2E+02	4.0E+05
75354	1,1-Dichloroethylene	NA	7.0E+01	9.00E-02	1.04E-05	2.60E-02	1.07E+00	5.89E+01	1.18E-01	2.61E-02	--	--	--	--	1.0E+02	6.0E+00	9.3E+01	1.7E+05
127184	Tetrachloroethylene (PCE)	5.9E-06	3.5E+01	7.20E-02	8.20E-06	1.84E-02	7.53E-01	1.55E+02	3.10E-01	1.08E-02	6.93E-01	4.08E-02	9.79E-01	9.1E+02	5.1E+01	3.0E+00	7.2E+01	6.7E+04
108883	Toluene	NA	3.0E+02	8.70E-02	8.60E-06	6.62E-03	2.72E-01	1.82E+02	3.64E-01	5.10E-03	--	--	--	--	4.4E+02	2.6E+01	9.0E+02	3.3E+05
71556	1,1,1-Trichloroethane	NC	2.2E+03	7.80E-02	8.80E-06	1.72E-02	7.03E-01	1.10E+02	2.20E-01	1.37E-02	NC	NC	NC	NC	3.2E+03	1.9E+02	4.0E+03	4.4E+06
79016	Trichloroethylene (TCE)	2.0E-06	6.0E+02	7.90E-02	9.10E-06	1.03E-02	4.21E-01	1.66E+02	3.32E-01	7.24E-03	2.04E+00	1.20E-01	3.52E+00	2.0E+03	8.8E+02	5.2E+01	1.5E+03	8.6E+05
108383	m,p-Xylenes	NA	7.0E+02	7.00E-02	7.80E-06	7.32E-03	3.00E-01	4.07E+02	8.14E-01	2.25E-03	--	--	--	--	1.0E+03	6.0E+01	3.2E+03	6.3E+05

Notes:
1. Risk-based screening levels (RBSL) calculated using the X/Q dispersion model and the VOC Emission Model presented in U.S.EPA, 1996, Soil Screening Guidance: Users Guide and Technical Background Document.

Abbreviations:
- atm-m^3/mole = atmospheres - cubic meter per mole
- CAS No. = chemical abstract service number
- cm^2/sec = square centimeters per second
- cm^3/g = cubic centimeters per gram
- L/kg = liters per kilogram
- $\mu g/cm^3$ = micrograms per cubic centimeter
- mg/L = micrograms per liter
- $\mu g/m^2$-sec = micrograms per square meter per second
- $\mu g/m^3$ = micrograms per cubic meter
- NA = not available
- NC = noncarcinogenic
- -- = not applicable

Equations:

$$C_{oa-risk} = \frac{TR \times ATca}{URF \times EF \times ED}$$

$$C_{oa-haz} = \frac{THQ \times ATnc}{EF \times ED \times 1/RfC}$$

$$E_i = \frac{C_{oa}}{X/Q}$$

$$CT = \frac{Ei \times \sqrt{\pi \times Da \times T}}{2 \times Da \times CF_{m2-cm2}}$$

$$RBSL_{soil vapor-oa} = \frac{CT}{[(pb \times Kd/H') + Pw/H' + Pa] \times CF_{cm3-L}}$$

TABLE B-11

RISK-BASED SCREENING LEVELS FOR CHEMICALS OF POTENTIAL CONCERN IN SOIL VAPOR --
CONSTRUCTION WORKER EXPOSURE TO AMBIENT AIR

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Inhalation Toxicity Criteria		Diffusivity in Air (Di) (cm^2/sec)	Diffusivity in Water (Dw) (cm^2/sec)	Henry's Law Constant (H) (atm-m^3/mole)	Dimensionless Henry's Law Constant (H') (unitless)	Organic Carbon Partition Coefficient (Koc) (L/kg)	Soil-Organic Partition Coefficient (Kd) (cm^3/g)	Effective Diffusivity (Da) (cm^2/sec)	Soil Vapor RBSL[1] -- Construction Worker: Cancer				Soil Vapor RBSL[1] -- Construction Worker: Noncancer			
		URF ($\mu g/m^3$)$^{-1}$	RfC ($\mu g/m^3$)								Ambient Air Screening Level ($\mu g/m^3$)	Emission Rate (Ei) ($\mu g/m^2$-sec)	Total Solute Concentration (CT) ($\mu g/cm^3$)	Soil Vapor Screening Level (µg/L)	Ambient Air Screening Level ($\mu g/m^3$)	Emission Rate (Ei) ($\mu g/m^2$-sec)	Total Solute Concentration (CT) ($\mu g/cm^3$)	Soil Vapor Screening Level (µg/L)
67663	Chloroform	5.3E-06	3.0E+02	1.04E-01	1.00E-05	3.66E-03	1.50E-01	3.98E+01	7.96E-02	1.07E-02	1.93E+01	1.14E+00	5.46E+00	3.5E+03	4.4E+02	2.6E+01	1.2E+02	7.9E+04
75354	1,1-Dichloroethylene	NA	7.0E+01	9.00E-02	1.04E-05	2.60E-02	1.07E+00	5.89E+01	1.18E-01	2.61E-02	--	--	--	--	1.0E+02	6.0E+00	1.9E+01	3.3E+04
127184	Tetrachloroethylene (PCE)	5.9E-06	3.5E+01	7.20E-02	8.20E-06	1.84E-02	7.53E-01	1.55E+02	3.10E-01	1.08E-02	1.73E+01	1.02E+00	4.90E+00	4.5E+03	5.1E+01	3.0E+00	1.4E+01	1.3E+04
108883	Toluene	NA	3.0E+02	8.70E-02	8.60E-06	6.62E-03	2.72E-01	1.82E+02	3.64E-01	5.10E-03	--	--	--	--	4.4E+02	2.6E+01	1.8E+02	6.6E+04
71556	1,1,1-Trichloroethane	NC	2.2E+03	7.80E-02	8.80E-06	1.72E-02	7.03E-01	1.10E+02	2.20E-01	1.37E-02	NC	NC	NC	NC	3.2E+03	1.9E+02	8.1E+02	8.8E+05
79016	Trichloroethylene (TCE)	2.0E-06	6.0E+02	7.90E-02	9.10E-06	1.03E-02	4.21E-01	1.66E+02	3.32E-01	7.24E-03	5.11E+01	3.01E+00	1.76E+01	1.0E+04	8.8E+02	5.2E+01	3.0E+02	1.7E+05
108383	m,p-Xylenes	NA	7.0E+02	7.00E-02	7.80E-06	7.32E-03	3.00E-01	4.07E+02	8.14E-01	2.25E-03	--	--	--	--	1.0E+03	6.0E+01	6.3E+02	1.3E+05

Notes:
1. Risk-based screening levels (RBSL) calculated using the X/Q dispersion model and the VOC Emission Model presented in U.S.EPA, 1996, Soil Screening Guidance: Users Guide and Technical Background Document.

Abbreviations:
- atm-m^3/mole = atmospheres - cubic meter per mole
- CAS No. = chemical abstract service number
- cm^2/sec = square centimeters per second
- cm^3/g = cubic centimeters per gram
- L/kg = liters per kilogram
- $\mu g/cm^3$ = micrograms per cubic centimeter
- mg/L = micrograms per liter
- $\mu g/m^2$-sec = micrograms per square meter per second
- $\mu g/m^3$ = micrograms per cubic meter
- NA = not available
- NC = noncarcinogenic
- -- = not applicable

Equations:

$$C_{oa-risk} = \frac{TR \times ATca}{URF \times EF \times ED}$$

$$C_{oa-haz} = \frac{THQ \times ATnc}{EF \times ED \times 1/RfC}$$

$$E_i = \frac{C_{oa}}{X/Q}$$

$$CT = \frac{Ei \times \sqrt{\pi \times Da \times T}}{2 \times Da \times CF_{m2-cm2}}$$

$$RBSL_{soilvapor-oa} = \frac{CT}{[(pb \times Kd/H') + Pw/H' + Pa] \times CF_{cm3-L}}$$

ATTACHMENTS

ATTACHMENT A-1
ADDITIONAL EQUATIONS USED IN SOIL VAPOR SCREENING LEVEL CALCULATIONS
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Estimation of Chemical Constants: (U.S. EPA, 1996)

$$H' = H / RT \qquad (1)$$

H' = Dimensionless Henry's Law Constant
H = Henry's Law Constant (atm-m^3/mole)
R = Universal gas constant (atm-m^3/mole-K)
T = Temperature (K)

$$Kd = Koc \times foc \qquad (2)$$

Kd = Soil-organic partition coefficient (cm^3/g)
Koc = Organic carbon partition coefficient (L/kg)
foc = Fraction organic-carbon (unitless)

Supporting Equations: (U.S. EPA, 1996)

$$X/Q = \frac{CF_{kg\text{-}mg}}{Q/C \times CF_{g\text{-}mg}} \qquad (3)$$

X/Q = Air dispersion factor (mg/m^3 per mg/m^2-sec)
Q/C = Inverse of dispersion factor (g/m^2-sec per kg/m^3)
$CF_{g\text{-}mg}$ = Conversion Factor from g to mg (mg/g)
$CF_{kg\text{-}mg}$ = Conversion Factor from kg to mg (mg/kg)

$$Q/C = A \times \exp[(\ln Ac - B)^2 \div C] \qquad (4)$$

Q/C = Inverse of dispersion factor (g/m^2-sec per kg/m^3)
Ac = Area of site (acres)
A = A Constant (Location - Los Angeles, CA)
B = B Constant (Location - Los Angeles, CA)
C = C Constant (Location - Los Angeles, CA)

ATTACHMENT A-1
ADDITIONAL EQUATIONS USED IN SOIL VAPOR SCREENING LEVEL CALCULATIONS
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Supporting Equations (continued): (U.S. EPA, 1996)

$$Da = \frac{[(Pa^{10/3} \times Di \times H' + Pw^{10/3} \times Dw) / Pt^2]}{pb \times Kd + Pw + Pa \times H'} \quad (5)$$

Da = Effective Diffusivity (cm^2/sec)
Pa = Air-filled soil porosity (unitless)
Di = Diffusivity in air (cm^2/sec)
H' = Dimensionless Henry's Law Constant
Pw = Water-filled soil porosity (unitless)
Dw = Diffusivity in water (cm^2/sec)
Pt = Total porosity (unitless)
pb = Soil bulk density (g/cm^3)
Kd = Soil-Organic partition coefficient (cm^3/g)

Abbreviations:
atm = atmospheres
cm^2 = square centimeters
cm^3 = cubic centimeters
g = grams
K = kelvin
kg = kilograms
L = liters
m^2 = square meters
m^3 = cubic meters
mg = milligrams
sec = seconds

ATTACHMENT A-2
RISK ASSESSMENT ASSUMPTIONS
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Parameter	Symbol	Value	Units	Source
Exposure Assumptions				
Target Risk	TR	1.0E-06	unitless	OEHHA, 2005a
Target Hazard Quotient	THQ	1.0E+00	unitless	OEHHA, 2005a
Duration - Commercial/Industrial	T_{ind}	7.9E+08	sec	Calculated
Duration - Construction	T_{cw}	3.2E+07	sec	Calculated
Site Assumptions				
Area of Source	Area	4576	m^2	Site-specific
Area of Source	Area_acres	1.13	acre	Site-specific
A Constant	A	11.91	unitless	Los Angeles
B Constant	B	18.44	unitless	Los Angeles
C Constant	C	209.78	unitless	Los Angeles
Air Dispersion Factor	X/Q	16.96	mg/m^3 per mg/m^2-sec	Calculated
Inverse of Dispersion Factor	Q/C	58.95	g/m^2-sec per kg/m^3	Calculated
Particulate Emission Factor				
Construction Worker	PEFcw	2.00E+07	m^3/kg	DTSC, 1999a[1]
Commercial/Industrial Worker	PEFow	1.32E+09	m^3/kg	OEHHA, 2005a
Temperature	T	295	Kelvin	Default
Soil Constants				
Fraction Organic Carbon	foc	0.002	unitless	Default
Air Filled Soil Porosity	Pa	0.321	unitless	Default for sandy soil type
Water Filled Soil Porosity	Pw	0.054	unitless	Default for sandy soil type
Total Porosity	Pt	0.375	unitless	Default for sandy soil type
Soil Bulk Density	rb	1.66	g/cm^3	Default for sandy soil type
Conversion Factors				
Conversion Factor from cm^3 to L	$CF_{cm3\text{-}L}$	1.0E-03	L/cm^3	Constant
Conversion Factor from m^3 to L	$CF_{m3\text{-}L}$	1.0E+03	L/m^3	Constant
Conversion Factor from g to mg	$CF_{g\text{-}mg}$	1.0E+03	mg/g	Constant
Conversion Factor from kg to mg	$CF_{kg\text{-}mg}$	1.0E+06	mg/kg	Constant
Conversion Factor from m^2 to cm^2	$CF_{m2\text{-}cm2}$	1.0E+04	cm^2/m^2	Constant

Notes:
1. Corresponds to a PM10 Ambient Air Quality Standard of 50 $\mu g/m^3$.

Abbreviations:
- cm^2 = square centimeters
- cm^3 = cubic centimeters
- g = grams
- kg = kilograms
- L = liters
- m^2 = square meters
- m^3 = cubic meters
- mg = milligrams
- sec = seconds

ATTACHMENT B-1
LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
OUTDOOR COMMERCIAL/INDUSTRIAL WORKER

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	3341
Lead in Water (ug/l)	15
% Home-grown Produce	7%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	12.4	22.7	26.8	32.6	37.1	662	1041
BLOOD Pb, CHILD	43.7	79.9	94.5	114.9	130.7	146	247
BLOOD Pb, PICA CHILD	67.3	122.9	145.4	176.7	201.1	94	159
BLOOD Pb, OCCUPATIONAI	3.3	6.1	7.2	8.8	10.0	3341	5253

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence[a]	ug/cm^2	200	200
Dermal uptake constant	(ug/dl)/(ug/da	0.0001	
Soil ingestion	mg/day	50	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/da	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/da	0.08	0.19
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	1503.5	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.1E-4	0.37	3%	4.0E-5	0.13	4%
Soil Ingestion	8.8E-4	2.94	24%	6.3E-4	2.10	63%
Inhalation, bkgrnd		0.05	0%		0.03	1%
Inhalation	2.5E-6	0.01	0%	1.8E-6	0.01	0%
Water Ingestion		0.84	7%		0.84	25%
Food Ingestion, bkgrnd		0.22	2%		0.23	7%
Food Ingestion	2.4E-3	8.00	64%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.19	0%		0.19	0%
Soil Ingestion	7.0E-3	23.52	54%	1.4E-2	47.04	70%
Inhalation	2.0E-6	0.01	0%		0.01	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		0.96	2%		0.96	1%
Food Ingestion, bkgrnd		0.50	1%		0.50	1%
Food Ingestion	5.5E-3	18.52	42%		18.52	28%

Notes:

a Default Lead Spread value replaced by soil adherence parameter used in the derivation of other risk-based screening levels (see Table B-3).

ATTACHMENT B-2
LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
CONSTRUCTION WORKER

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	982
Lead in Water (ug/l)	15
% Home-grown Produce	7%
Respirable Dust (ug/m^3)	1.5

OUTPUT							
	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	6.6	12.0	14.2	17.3	19.7	402	632
BLOOD Pb, CHILD	13.9	25.4	30.1	36.6	41.6	146	247
BLOOD Pb, PICA CHILD	20.8	38.0	45.0	54.7	62.3	94	159
BLOOD Pb, OCCUPATIONAI	3.3	6.1	7.2	8.8	10.0	982	1545

EXPOSURE PARAMETERS			
	units	adults	children
Days per week	days/wk	7	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational[a]	cm^2	5800	
Soil adherence[a]	ug/cm^2	510	200
Dermal uptake constant	(ug/dl)/(ug/da	0.0001	
Soil ingestion[b]	mg/day	165	100
Soil ingestion, pica	mg/day		200
Ingestion constant	(ug/dl)/(ug/da	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/da	0.08	0.19
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in home-grown produce	ug/kg	441.9	

PATHWAYS						
ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	2.8E-4	0.27	4%	2.0E-4	0.20	6%
Soil Ingestion	2.9E-3	2.85	43%	2.1E-3	2.04	61%
Inhalation, bkgrnd		0.05	1%		0.03	1%
Inhalation	2.5E-6	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	13%		0.84	25%
Food Ingestion, bkgrnd		0.22	3%		0.23	7%
Food Ingestion	2.4E-3	2.35	36%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	5.6E-5	0.05	0%		0.05	0%
Soil Ingestion	7.0E-3	6.91	50%	1.4E-2	13.83	66%
Inhalation	2.0E-6	0.00	0%		0.00	0%
Inhalation, bkgrnd		0.04	0%		0.04	0%
Water Ingestion		0.96	7%		0.96	5%
Food Ingestion, bkgrnd		0.50	4%		0.50	2%
Food Ingestion	5.5E-3	5.44	39%		5.44	26%

Notes:

a Default Lead Spread value replaced by value used in the derivation of other risk-based screening levels (see Table B-4).

b Default Lead Spread value replaced by 50 percent of the soil ingestion rate used in the derivation of other risk-based screening levels.

Attachment C-1: Soil Vapor Attenuation Factors for Vapor Intrusion, COPCs in Soil Vapor -- Indoor Commercial/Industrial Worker, Data Entry Sheet

SL-ADV
Version 3.0; 02/03

Geomatrix Version, 1.0.1
modified by MJC, Jan 2004
includes Cal-EPA CSFs

CALCULATE RISK-BASED SOIL CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL SOIL CONCENTRATION (enter "X" in "YES" box and initial soil conc. below)

YES [X]

ENTER
U.S. EPA or Cal-EPA: Cal-EPA

Enter initial soil concentration.

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial soil conc., C_R (mg/kg)	Chemical
67663		Chloroform
75354		1,1-Dichloroethylene
127184		Tetrachloroethylene
108883		Toluene
71556		1,1,1-Trichloroethane
79016		Trichloroethylene
106423		p-Xylene

MORE ê

Totals must add up to value of L_t (cell G38)

ENTER Average soil temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to top of contamination, L_t (cm)	ENTER Depth below grade to bottom of contamination, (enter value of 0 if value is unknown) L_b (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
22	9	49	0	9	10	30	S		

MORE ê

ENTER Stratum A SCS soil type	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm³/cm³)	ENTER Stratum A soil organic carbon fraction, f_{oc}^A (unitless)	ENTER Stratum B SCS soil type	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum B soil organic carbon fraction, f_{oc}^B (unitless)	ENTER Stratum C SCS soil type	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)	ENTER Stratum C soil organic carbon fraction, f_{oc}^C (unitless)
S	1.66	0.375	0.054	0.002	S	1.66	0.375	0.054	0.002	SIC	1.80	0.30	0.15	0.002

MORE ê

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, DP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
9	40	1000	1000	244	0.1	1	5

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1

Used to calculate risk-based soil concentration.

END

Attachment C-1: Soil Vapor Attenuation Factors for Vapor Intrusion, COPCs in Soil Vapor -- Indoor Commercial/Industrial Worker, Chemical Properties Sheet

	Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF $(mg/m^3)^{-1}$	Reference conc., RfC (mg/m^3)	Physical state at soil temperature, (S,L,G)
Chloroform	1.04E-01	1.00E-05	3.66E-03	25	6,988	334.32	536.40	3.98E+01	7.92E+03	5.3E-06	3.0E-01	L
1,1-Dichloroethylene	9.00E-02	1.04E-05	2.60E-02	25	6,247	304.75	576.05	5.89E+01	2.25E+03	0.0E+00	7.0E-02	L
Tetrachloroethylene	7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02	L
Toluene	8.70E-02	8.60E-06	6.62E-03	25	7,930	383.78	591.79	1.82E+02	5.26E+02	0.0E+00	3.0E-01	L
1,1,1-Trichloroethane	7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	1.10E+02	1.33E+03	0.0E+00	2.2E+00	L
Trichloroethylene	7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	2.0E-06	6.0E-01	L
p-Xylene	7.69E-02	8.44E-06	7.64E-03	25	8,525	411.52	616.20	3.89E+02	1.85E+02	0.0E+00	7.0E-01	L

END

Attachment C-1: Soil Vapor Attenuation Factors for Vapor Intrusion, COPCs in Soil Vapor -- Indoor Commercial/Industrial Worker, Intermediate Calculations Sheet

	Exposure duration, t (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, q_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, q_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, q_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Floor-wall seam perimeter, X_{crack} (cm)	Initial soil concentration used, C_R (mg/kg)	Bldg. ventilation rate, $Q_{building}$ (cm^3/s)
Chloroform	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
1,1-Dichloroethylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
Tetrachloroethylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
Toluene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
1,1,1-Trichloroethane	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
Trichloroethylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04
p-Xylene	7.88E+08	40	0.321	0.321	0.150	0.003	1.01E-07	0.998	1.01E-07	4,000	0.00E+00	6.78E+04

	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, h (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $DH_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} ($atm\text{-}m^3/mol$)	Henry's law constant at ave. soil temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, m_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)	Convection path length, L_p (cm)
Chloroform	1.00E+06	4.00E-04	9	7,429	3.22E-03	1.33E-01	1.79E-04	1.68E-02	1.68E-02	2.09E-03	2.67E-03	40	9
1,1-Dichloroethylene	1.00E+06	4.00E-04	9	6,313	2.34E-02	9.65E-01	1.79E-04	1.45E-02	1.45E-02	1.80E-03	2.31E-03	40	9
Tetrachloroethylene	1.00E+06	4.00E-04	9	9,431	1.56E-02	6.45E-01	1.79E-04	1.16E-02	1.16E-02	1.44E-03	1.85E-03	40	9
Toluene	1.00E+06	4.00E-04	9	9,023	5.67E-03	2.34E-01	1.79E-04	1.41E-02	1.41E-02	1.75E-03	2.23E-03	40	9
1,1,1-Trichloroethane	1.00E+06	4.00E-04	9	7,754	1.50E-02	6.20E-01	1.79E-04	1.26E-02	1.26E-02	1.56E-03	2.00E-03	40	9
Trichloroethylene	1.00E+06	4.00E-04	9	8,407	8.89E-03	3.67E-01	1.79E-04	1.28E-02	1.28E-02	1.58E-03	2.03E-03	40	9
p-Xylene	1.00E+06	4.00E-04	9	10,107	6.42E-03	2.65E-01	1.79E-04	1.24E-02	1.24E-02	1.54E-03	1.98E-03	40	9

	Soil-water partition coefficient, K_d (cm^3/g)	Source vapor conc., C_{source} (mg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, a (unitless)	Infinite source bldg. conc., $C_{building}$ (mg/m^3)	Finite source b term (unitless)	Finite source y term $(sec)^{-1}$	Time for source depletion, t_D (sec)	Exposure duration > time for source depletion (YES/NO)
Chloroform	7.96E-02	0.00E+00	0.10	8.33E+01	1.68E-02	4.00E+02	2.72E+48	5.47E-04	0.00E+00	NA	NA	NA	NA
1,1-Dichloroethylene	1.18E-01	0.00E+00	0.10	8.33E+01	1.45E-02	4.00E+02	9.30E+55	5.03E-04	0.00E+00	NA	NA	NA	NA
Tetrachloroethylene	3.10E-01	0.00E+00	0.10	8.33E+01	1.16E-02	4.00E+02	9.13E+69	4.39E-04	0.00E+00	NA	NA	NA	NA
Toluene	3.64E-01	0.00E+00	0.10	8.33E+01	1.41E-02	4.00E+02	7.91E+57	4.93E-04	0.00E+00	NA	NA	NA	NA
1,1,1-Trichloroethane	2.20E-01	0.00E+00	0.10	8.33E+01	1.26E-02	4.00E+02	3.79E+64	4.61E-04	0.00E+00	NA	NA	NA	NA
1. Risk-based screening levels (	3.32E-01	0.00E+00	0.10	8.33E+01	1.28E-02	4.00E+02	5.78E+63	4.65E-04	0.00E+00	NA	NA	NA	NA
p-Xylene	7.78E-01	0.00E+00	0.10	8.33E+01	1.24E-02	4.00E+02	3.18E+65	4.57E-04	0.00E+00	NA	NA	NA	NA